

# MINDLESS SENSATIONALISM: A QUANTUM FRAMEWORK FOR CONSCIOUSNESS \*

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I write as a physicist, with the knowledge that many physicists are studying the mathematical structure of our physical universe and hope to be able to find a ‘theory of everything,’ or TOE, that will give a complete set of dynamical laws for this structure. This would essentially give the rules for how all the physical quantities in the universe evolve. Such a TOE would not be itself give the boundary conditions also necessary to determine the history of the universe, so it is a misnomer to say that it is a ‘theory of everything,’ but it is convenient to retain the acronym TOE for this dynamical part of the laws of physics. Some physicists, such as Hartle and Hawking [1], are also seeking to find rules specifying the boundary conditions (BC) of the universe as well. The combination of the TOE and the BC would then give a complete description of the mathematics of the state of the universe and its evolution. (This might be called a ‘Theory Of More of Everything,’ or TOME.)

However, if one takes an even broader view, one realizes that even the TOME (the TOE and the BC) would not really comprise a theory of everything either, since they do not specify what conscious experiences occur within the universe. At least this seems to be the case if the TOME is assumed to be of the general mathematical types that are currently being sought, since such types do not seem by themselves to specify precisely what conscious experiences occur.

Nevertheless, there is the general consensus that there should be some sort of ‘psycho-physical parallelism’ or connection between the mathematical structures described by current and sought-for theories of physics and the conscious experiences

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that each of us apparently has. Indeed, it can be argued that all we directly experience are these conscious experiences themselves, and our feelings that there is a mathematical structure for the physical world seems to be ultimately based upon the enormous success of our partial glimmerings of such a structure in explaining many aspects of our conscious experiences. In other words, we do not seem to experience directly the mathematical structure at all, but we seem to experience the feeling that our partial theories for such a structure help us better understand our experiences.

For example, as part of some of my conscious experiences while writing this, I have a feeling that I am looking at a computer screen that (except for the details of what is displayed upon it) is very similar to what I would consider to be the same computer screen that I think I remember viewing at many times in the past. Furthermore, I have the feeling that my understanding of the feeling of the existence and persistence of certain properties of what I interpret to be the computer screen in front of me, is helped by my effective partial theory of the existence of this screen as a physical object and of its approximate “object permanence” over the relevant timescales. (Incidentally, I do not believe that any ultimate theory of physics will have any precisely existing persons such as “I,” any precisely existing “objects” such as computers screens, any absolute notions of “personal identity” or “object permanence,” or even any absolute notion of time or of timescales, but to illustrate my ideas, I am merely using the crude notions from a rough instrumentalist theory to denote how “I” feel “I” “believe” ideas about an “external” “physical” world seem to help explain my “internal” “mental” experiences.)

Therefore, very crudely, I think that I have the experience of remembering my computer screen as a persisting object because, according to my rough theory, there is such an object in the physical world.

Such a rough theory can be refined, and I might believe that a better theory claims that my conscious experience is more directly correlated with (or is “caused by”) certain physical processes within my brain. The point is that it certainly seems to have explanatory value to assume that in some sense there exists a physical world, and that our conscious experiences are either part of it or else are correlated with it.

Of course, it is logically possible that only the conscious experiences by themselves exist (or even just the one conscious experience that I am having “now,” to take an extreme solipsistic view that denies even the existence of my past experiences as anything other than the partial contents within the memory components of my present experience). However, the experienced correlation between the different components of the content of even my present experience would then seem to lack the explanation that appears possible from the assumed existence of an external physical world.

Therefore, I shall assume that an external physical world does exist in some

sense and is helpful for explaining our conscious experiences. For it to be helpful, it must be connected or correlated with the internal conscious experiences in some way, and this connection is the ‘psycho-physical parallelism’ or PPP that I shall assume exists.

Now the question arises as to what the form is of this assumed ‘psycho-physical parallelism.’ This form will of course be dependent upon the form of the two entities that are being connected, the internal conscious experiences and the external physical world. I am certainly no expert on the academic work that has been done on theories of the form of the internal conscious experiences, though I can claim to experience at least one of them directly myself. On the other hand, I have done academic work for many years on theories for the form of the external physical world, and so I have some idea of the constraints of current physical theories on that end of the psycho-physical connection, even though we physicists certainly do not yet have the complete physical theory or TOME described above, and I would not be personally competent to assess it fully even if we physicists as a community did have such a theory.

An essential point here is that, so far as we know, and so far as current physics theories give any strong hint, the external physical world seems to be thoroughly quantum mechanical. Therefore, as Quentin Smith [2] has emphasized in this volume, a realistic theory of the ‘psycho-physical parallelism’ should include the quantum nature of the physical world in order to be consistent with the most basic feature of our current best theories of physics.

I should say that, unlike some, I do not believe that it is necessarily impossible for there to exist a (different) universe in which the physics is entirely classical and yet conscious experiences exist and are correlated with that external physical world. However, I am strongly convinced that such a classical universe is not ours, and so if we want a correct theory of the psycho-physical connection for our universe, we must include the quantum nature of our universe (or possibly whatever it is that replaces the quantum if our current quantum theories are entirely superseded, though I think it highly unlikely that such a future theory would revert entirely to the completely classical picture held before quantum theory was discovered).

Of course, there are a multitude of ways in which one might postulate a connection between conscious experiences and a quantum physical world. Quentin Smith [2], Barry Loewer [3], and Michael Lockwood [4] have discussed three within this volume. However, rather than reviewing the various possibilities that have been proposed, I wish to summarize my own conjecture for the framework or basic form of the connection. When emphasizing the quantum side of the connection, I have called this Sensible Quantum Mechanics (SQM) [5, 6], but, for reasons that will become apparent, when emphasizing the conscious side of the connection, I might call it Mindless Sensationalism (MS).

Mindless Sensationalism is very similar in many ways to the many-minds theories

developed by Lockwood [7, 8, 9, 4] and by David Albert and Loewer [10, 11], except that the basic conscious entities, which Mindless Sensationalism asserts there are “many” of, are conscious experiences rather than minds.

By a “conscious experience,” I mean all that one is consciously aware of or consciously experiencing at once. Lockwood has called this a “phenomenal perspective” or “maximal experience” or “conscious state.” It could also be expressed as a total “raw feel” that one has at once. In my papers on Sensible Quantum Mechanics [5, 6], I have usually called it merely a “perception” or sometimes an “awareness” or “sensation,” but I do not wish to imply that I am using the same subtle meanings for those terms that others might. For example, I am not merely considering an individual sensory perception, or even just the set of simultaneous sensory perceptions of things external to the brain. Instead, what I mean by a conscious experience or perception is a total conscious awareness, a “subjective,” “internal,” “first-person” experience by roughly what one crudely thinks of as one conscious “being,” at roughly the one “time” that is then felt by the conscious “being” to be “now.” (However, I hasten to say that I doubt the absolute existence of any uniquely identifiable conscious “beings” within our universe, and I also doubt the existence of any entity with the precise properties commonly ascribed to “time,” except possibly for the admitted existence of mental concepts within the contents of certain conscious experiences themselves. For me the conscious experiences themselves are the fundamental entities, and it is only in trying to illustrate, in commonly understood language, what I mean by them, that I am apparently forced to describe them in terms of what I regard as less fundamental concepts such as “conscious beings” and “at one time” or “now.”)

A conscious experience can include components such as a visual sensation, an auditory sensation, a pain, a conscious memory, a conscious impression of a thought or belief, etc., that are all experienced together. However, it does not include a sequence of more than one immediate experience that in other proposals might be considered to be strung together to form a stream of consciousness of an individual mind.

Because I regard the basic conscious entities to be the conscious experiences themselves, which might crudely be called sensations if one does not restrict the meaning of this word to be the conscious responses only to external stimuli, and because I doubt that these conscious experiences are arranged in any strictly defined sequences that one might define to be minds if they did exist, my framework has sensations without minds and hence may be labeled Mindless Sensationalism.

I should also emphasize that by a conscious experience, I mean the phenomenal, first-person, “internal” subjective experience, and not the unconscious “external” physical processes in the brain that accompany these subjective phenomena. In his first chapter, Chalmers [12] gives an excellent discussion of the distinction between the former, which he calls the phenomenal concept of mind, and the latter, which

he calls the psychological concept of mind. In his language, what I mean by a conscious experience (and by other approximate synonyms that I might use, such as perception or sensation or awareness) is the phenomenal concept, and not the psychological one.

Now that I have tried to illustrate what I mean by the conscious experiences that I take to be the basic entities that make up what might be called the “internal” mental world (which I shall here call the “conscious world”), let me turn to a quantum description of what might be called the “external” physical world. (This world I shall here call the “quantum world” to avoid offending the materialists who say that consciousness is part of the “material world,” whatever that is supposed to mean, and to avoid offending the physicists, myself included, who claim that consciousness is part of the “physical world,” whatever that is supposed to mean—as a physicist I shall take it to mean roughly whatever is studied by those who consider themselves doing physics. I’ll nevertheless inevitably offend the smaller number of quantumists who consider consciousness to be a quantum phenomenon, but I want some short phrase to denote the non-conscious aspects of a physics description of our universe, without of course intending to deny that there is a relation between consciousness and the quantum world.)

For those who object that my terminology implies an unrealistic dualism between the internal mental world and the external physical world (between the “conscious world” and the “quantum world” as I am using these terms), I can say that I do not wish to imply that there is necessarily a fundamental distinction between these two “worlds,” but at the present level of description it seems to help to recognize the distinction between the two ways of describing aspects of our universe. Physicists often try to describe some aspects of our universe by using the mathematical language of current physics and ignoring consciousness, and it seems that others (idealists?) can consider conscious experiences separately from the aspects of our universe that physicists usually consider. There may be a deeper level of understanding at which the “conscious world” and the “quantum world” are unified, but to get to this level it does not seem to me to help to pretend that at our present level of understanding our descriptions do not usually make a distinction between what appears to be these two different aspects of reality.

Rather than restricting attention to particular theories or theoretical frameworks for the quantum world, such as nonrelativistic quantum mechanics, relativistic quantum field theory, quantum gravity, or quantum string or M theory, I shall here focus on what I consider to be the basic elements of quantum theory as I presently understand it.

In the Feynman path-integral approach, the basic elements of quantum theory might be a set of “paths” or fine-grained histories allowed for the universe, and a rule for assigning to each such history a complex number called an “amplitude” (a number of the form of a real number plus  $i$ , the square root of  $-1$ , times another real

number; the complex number is itself real if the real number multiplying  $i$  is 0). (The dynamical ‘theory of everything’ or TOE would then be primarily concerned with specifying the rule for assigning the amplitudes, and the boundary conditions or BC would essentially tell what paths are to be included.) That is not the whole story in this approach, however, as there seems to be a need to combine the individual paths into appropriate sets of paths and add up the amplitudes for all the paths in each set. Precisely how this is to be done is a bit mysterious to me, and so I find it a bit clearer to try to relate consciousness more directly to another approach to quantum theory, which might be called the operator approach. (There are crude rules for which amplitudes in the path-integral approach to add up in practical situations, but I’m not sure these rules are not implicitly invoking some assumptions about something like consciousness, whereas at the level of discussing only what I am calling the quantum world, I would like to start with a set of structures that do not depend in any way on consciousness.)

In the operator approach, the basic elements of quantum theory might be a set of “operators” obeying some algebra (rules for adding and multiplying them), along with some “quantum state” (or simply “state”) for the universe that determines a complex number called the “expectation value” for each operator. I shall give some examples below, but for now one can think of the operators as some abstract mathematical entities that can be multiplied by complex numbers, added or subtracted, and multiplied together to give other operators. The expectation value of the operators, determined by the quantum state, is required to be linear in that the expectation value of the new operator that is a certain complex number times the old operator is simply that complex number times the expectation value of the old operator, and the expectation value of the sum of two operators is simply the sum of the expectation values of the two separate operators. (However, the expectation value of the product of two operators is not, in general, the product of the expectation values of the two separate operators.)

In the operator approach, the operators are somewhat analogous to the amplitudes for the paths in the path-integral approach and so would be the part primarily determined by the TOE. Similarly, the quantum state is somewhat analogous to the set of allowed paths in the path-integral approach and so would be primarily determined by the BC. Getting the expectation value for an operator would be analogous to adding up the amplitudes for a certain set of paths. (Actually, on this issue the operator approach seems a bit more complete, since to say what an operator means in the path-integral approach, one needs to say which set of paths contribute to each operator, usually with an additional complex weighting factor besides the amplitudes for the paths themselves.)

As an example of the operator approach, consider the example of a ‘universe’ consisting of a single nonrelativistic particle moving in one spatial dimension, e.g., along the  $x$ -axis. In this simple case, the quantum states can be represented by

‘wavefunctions’ that are complex functions of  $x$ , say  $\psi(x)$ , and which are square-integrable, meaning in this case that the integral of  $|\psi(x)|^2$  over all  $x$  is finite. (The absolute value squared of a complex number, such as  $\psi = \psi_R + i\psi_I$  with  $\psi_R$  and  $\psi_I$  being the two real numbers that make it up, is  $|\psi|^2 = \psi_R^2 + \psi_I^2$ , a real nonnegative quantity that is the square of the distance, from the origin, of the point representing  $\psi$  on the complex plane, which itself has a horizontal, or ‘real,’ axis representing the real part,  $\psi_R$ , of the complex number  $\psi$ , and a vertical, or ‘imaginary,’ axis representing the imaginary part,  $\psi_I$ , of the complex number  $\psi$ .)

In this one-dimensional quantum example, operators are mathematical entities that represent ways of changing one wavefunction to another in a linear way. For example, corresponding to the position  $x$  that the particle might be considered to have in a classical description, there is the quantum position operator, say  $X$ , that converts a wavefunction  $\psi(x)$  to the wavefunction  $x\psi(x)$ . (Strictly speaking,  $X$  is not really a well-defined operator if the space of states is represented by all square-integrable wavefunctions, since there exist square-integrable wavefunctions  $\psi(x)$ , such as  $\psi(x) = 1/\sqrt{\pi(1+x^2)}$ , for which  $x\psi(x)$  is not square-integrable, but to get a simple example, I shall here ignore the mathematical technicalities that one can use to get a class of wavefunctions for which  $X$  is a good operator.) Similarly, corresponding to the momentum  $p$  that the particle might have in a classical description, there is the quantum momentum, say  $P$ , that converts a wavefunction  $\psi(x)$  to the wavefunction  $-id\psi(x)/dx$ .

Operators change states in linear ways, so for complex numbers  $a$  and  $b$ , the operator  $aX + bP$  converts a wavefunction  $\psi(x)$  to the wavefunction  $ax\psi(x) - ibd\psi(x)/dx$ .

The product of two operators, such as  $PX$ , has the effect of performing the operations on the right first, followed by the operation to the left. Thus  $PX$  converts a wavefunction  $\psi(x)$  to the wavefunction  $-id(x\psi(x))/dx = -ixd\psi(x)/dx - i\psi(x)$ . Note that, in general, the product of two operators depends on the order in which they are taken, so  $XP$  converts a wavefunction  $\psi(x)$  to the wavefunction  $-ixd\psi(x)/dx$ , the same as  $PX - iI$  does, where  $I$  is the identity operator that converts a wavefunction  $\psi(x)$  to the same wavefunction  $\psi(x)$ . This example shows that, for any wavefunction,  $XP = PX - iI$  or  $PX - XP = iI$ . (This is a so-called commutation relation, since  $PX - XP$ , which is mathematically denoted by  $[P, X]$ , is called the commutator of  $P$  and  $X$ . This commutation relation is what essentially gives the Heisenberg uncertainty relation for momentum and position, but it would take me too far afield to explain that here.)

Now that I have given an example of operators from one-dimensional nonrelativistic quantum mechanics, let me illustrate how quantum states give expectation values to operators. In Dirac’s ‘bracket’ notation, a ‘pure’ quantum state can be written as the ‘ket’  $|\psi\rangle$ , which in my example is represented by the wavefunction  $\psi(x) = \psi_R + i\psi_I$ , or alternatively, it can be written as the ‘bra’  $\langle\psi|$ , which is rep-

represented by the complex conjugate wavefunction  $\bar{\psi}(x) = \psi_R(x) - i\psi_I(x)$ . A slightly better representation of the pure state is the combination  $|\psi\rangle\langle\psi|$ , which avoids the phase ambiguity in representing a pure state by either  $|\psi\rangle$  or  $\langle\psi|$  individually, since the state is physically the same if  $|\psi\rangle$  is multiplied by the complex phase factor  $e^{i\theta} = \cos\theta + i\sin\theta$  and  $\langle\psi|$  is multiplied by the complex conjugate phase factor  $e^{-i\theta} = \cos\theta - i\sin\theta$  for some real angle  $\theta$  measured in radians (degrees divided by 180 and multiplied by  $\pi$ , so that a 180-degree rotation is represented by  $\theta = \pi$ , which gives  $e^{i\theta} = e^{-i\theta} = -1$ ). The phase factor has no physical consequences, and indeed  $|\psi\rangle\langle\psi|$  remains unchanged by it, since  $e^{i\theta}e^{-i\theta} = 1$  so that  $e^{i\theta}|\psi\rangle\langle\psi|e^{-i\theta} = |\psi\rangle\langle\psi|$ .

The result of an operation, say  $X$ , on a quantum state denoted by  $|\psi\rangle$  can be then denoted as  $X|\psi\rangle$ , say  $|\phi\rangle$ , and represented by the wavefunction  $\phi(x)$  (which in this particular case is  $x\psi(x)$ ). Then the expectation value of  $X$ , denoted by  $\langle X \rangle$ , is the ‘inner product’ of the bra  $\langle\psi|$  with the ket  $|\phi\rangle = X|\psi\rangle$ , which is

$$\langle X \rangle = \langle\psi|X|\psi\rangle = \langle\psi|\phi\rangle = \int_{-\infty}^{\infty} dx \bar{\psi}(x)\phi(x) = \int_{-\infty}^{\infty} dx \bar{\psi}(x)x\psi(x). \quad (1)$$

One can readily see from this example that the expectation value is linear in the operators, e.g.

$$\langle aX + bP \rangle = a\langle X \rangle + b\langle P \rangle, \quad (2)$$

but in general,

$$\langle XP \rangle \neq \langle X \rangle \langle P \rangle. \quad (3)$$

Although for my purposes below it is generally sufficient to think of the universe as having a pure quantum state, for completeness I should say that besides the pure states best represented by the single term  $|\psi\rangle\langle\psi|$ , one can have ‘mixed’ or ‘statistical’ states represented by a sum of such terms,

$$\rho = \sum_{i,j} c_{ij} |\psi_j\rangle\langle\psi_i|, \quad (4)$$

with a set of different kets  $|\psi_i\rangle$  and bras  $\langle\psi_j|$ , where the  $c_{ij}$ ’s form what is known as the density matrix, which is Hermitian ( $c_{ij} = \bar{c}_{ji}$ ), positive (eigenvalues non-negative), and normalized (eigenvalues summing to unity). For such a state, the expectation value of an operator such as  $X$  is

$$\langle X \rangle = \text{tr}(X\rho) = \sum_{i,j} c_{ij} \langle\psi_i|X|\psi_j\rangle. \quad (5)$$

For infinitely large systems, there are even more general states, known as C\*-algebra states, which need not be represented by normalized density matrices. Instead, such states are represented by positive linear functionals of the operators. (A functional of a set of operators is something analogous to a formula that gives a number for each operator. A positive functional gives positive numbers for positive operators, which are operators that have positive eigenvalues. A linear functional



gives a number for the sum of two operators that is the sum of the two numbers that it would give for each operator individually.) If such a state is written symbolically as  $\sigma$ , then one can write the expectation value of an operator like  $X$  as  $\langle X \rangle = \sigma[X]$ . The pure and mixed states described above are then special cases of these more general  $C^*$ -algebra states, so for generality we can denote any quantum state by a positive linear functional  $\sigma$ .

So far I have not put time into the picture. I believe that time is not a basic fundamental part of physics, so in the ultimate description of the quantum world (at least if it continues to use what I am here regarding as the fundamental entities of quantum theory), there will be operators and a quantum state for the universe, but no time. However, in most of our approximate quantum theories for models of parts of the universe, time does enter. For example, in nonrelativistic quantum theory, in the Heisenberg picture I shall use when speaking of time, the quantum state is considered to be independent of time, but the operators, like  $X$  and  $P$ , are defined to be functions of the time  $t$ , as  $X(t)$  and  $P(t)$ . (The wavefunction that represents the time-independent quantum state  $|\psi\rangle$  is then also a function of time,  $\psi(x, t)$ .) Then the quantum algebra relates the operators at different times. For example, for a free particle of unit mass, the relation takes the simple form

$$X(t) = X(0) + tP(0) \tag{6}$$

and

$$P(t) = P(0). \tag{7}$$

The form of the relation of these operators at different times, which I am considering to be part of the algebra of the operators, depends on the dynamics of the system, for example on the forces on the particle in this simple one-dimensional example. One might say that if time does not really exist, then there is no dynamics, which would trivialize the TOE, but I take the attitude that it is the algebra of the operators (the rules giving all their sums and products) that represents the dynamics, and this can persist even if time as we usually know it does not.

I might add that even if one has time within some model system, such as the one-dimensional nonrelativistic quantum mechanical model described above, if this system is really a closed quantum system, what I believe is important about it is described by the quantum state and the quantum operators, but not the representation of the operators at various times. For example, in Eq. (6), even though  $X(t)$  has a different representation from  $X(0) + tP(0)$ , I believe there is fundamentally no distinction between them, because they are equal operators. Therefore, even in models in which a time such as  $t$  exists, the operators cannot be uniquely identified with any single time, and so what I regard as the basic quantum entities are effectively timeless. Only if one augments the basic quantum theory of states and operators with distinctions between different forms of the same operators, such as

the left and right hand sides of Eq. (6), does one get any real dependence upon the time parameter  $t$ .

If the quantum world is described by operators and states (with our universe being described by one particular set of operators and by a particular state, the so-called ‘quantum state of the universe’), then a goal of a theory of psycho-physical parallelism (PPP) would be to give the connection between the quantum state of the universe and the conscious experiences occurring within it. Eschewing the extreme solipsistic view that only my present conscious experience exists, I assume that many conscious experiences exist within the universe, so a PPP should give many conscious experiences for a single quantum state.

Suppose that one denotes an individual conscious experience by the letter  $p$  and defines the “conscious world”  $M$  as the set of all possible conscious experiences in all universes with all possible quantum states (i.e., not just in our universe with its particular quantum state  $\sigma$ ). One logically possible view would be that all possible conscious experiences exist equally, regardless of the quantum state. But this would make the quantum world completely irrelevant for the existing conscious experiences, and so the apparent order that I sense within my present experience would not at all be explained by any postulated quantum world. On the contrary, I feel that the order that I sense within my own experience is better explained by assuming that there is a quantum world and that the conscious experiences are in some sense correlated with it. Therefore, I shall make this assumption, that there is indeed a nontrivial psycho-physical parallelism.

The next possibility one can consider is the assumption that the quantum state of the universe restricts the set of conscious experiences that actually exist to be a proper subset, say  $E$ , of the set  $M$  of all possible conscious experiences, but that each conscious experience within the existing set  $E$  is equally real. This would seem to be a reasonable assumption if the quantum world were actually classical, so that some physical possibilities definitely happen and others do not. Then it would be plausible that some conscious experiences definitely happen and that others do not.

For example, suppose that one takes a simplified nonrelativistic classical model in which there are a certain set of pointlike elementary particles that move along definite trajectories through space as a function of time, so that at each time there is a definite configuration of the positions of these particles in space. The temporal sequence of these configurations could then be called the classical history of this universe. Certain sets of the configurations might be identified as conscious brain states, and for each of these one might identify a corresponding conscious experience  $p$ . Then one might propose that if a configuration corresponding to the conscious experience  $p$  occurs during the classical history of this universe, then this conscious experience exists, but if the configuration never occurs, the corresponding conscious experience does not exist either. If there is some correspondence between the orderliness of the physical brain configurations and the orderliness perceived within

the conscious experience, then an orderly history could explain orderly conscious experiences.

A similar picture with a definite sequence of configurations occurs in the deBroglie-Bohm version of nonrelativistic quantum theory [14, 15, 16, 17, 18], in which to the normal operators and state there is added a definite trajectory whose evolution, but not whose initial configuration, is determined by the wavefunction, which acts as a ‘pilot wave.’ However, it seems to me unnecessary to add a trajectory to quantum theory, which for completeness would require a specification of its initial configuration as additional information. It also seems very ugly to try to do this for examples beyond nonrelativistic quantum mechanics. For example, in relativistic quantum field theory, a trajectory of sequences of field configurations that obeyed Bohm’s equation for the evolution of the configurations using the time corresponding to one observer would not obey that equation using instead the time corresponding to a moving observer, so that relativistic invariance would be broken by the trajectories.

However, in a quantum theory with operators and a state, unless one adds extra elements like the definite trajectory of Bohm’s version of quantum theory, it seems difficult or ugly to have the operators and state give a definite rule for saying that some possible conscious experiences definitely exist but that others do not. It is much easier to have a rule assigning different (nonnegative real) weights or levels of reality to different conscious experiences, with the rule depending upon the quantum state of the universe. Then if all conscious experiences with positive weights  $w$  are said to exist, but if experiences with greater weights exist in some sense more, then one might expect that it is more likely that one’s experience would be one that has greater weight. (One might like to propose that one simply takes all possible conscious experiences with positive weight as existing and all possible conscious experiences with zero weight as not existing, but for the simplest ways of assigning the weights from quantum theory, such as what I shall give below, almost all of the possible conscious experiences would have a weight at least a tiny bit positive, so this proposal would exclude as nonexistent only an infinitesimally small fraction of the total set  $M$  of conscious experiences  $p$ . Therefore, I am not considering this particular proposal further.)

In other words, if the weight  $w(p)$  gives the level of reality or existence of the conscious experience  $p$ , one can say that in the universe almost all possible conscious experiences exist in the sense of having at least some positive measure of reality, but some sets of experiences are much more real than others, existing to a much greater degree than other sets. One way to describe this is to imagine randomly selecting a conscious experience  $p$  out of all of the possible ones. For a random selection one always needs a weight, and if it is chosen to be the weight  $w(p)$  that comes from the quantum state  $\sigma$  by some particular theory of psycho-physical parallelism, then the probability that a particular conscious experience  $p$  will be chosen by the random selection will be proportional to its weight  $w(p)$ .

In this way one can say that the weight  $w(p)$  is analogous to the probability for the conscious experience  $p$ , but it is not to be interpreted as the probability for the bare *existence* of  $p$ , since any conscious experience  $p$  exists (is actually experienced) if its weight is positive,  $w(p) > 0$ . Rather,  $w(p)$  is to be interpreted as being proportional to the probability of *getting* this particular experience if a random selection is made.

A more picturesque way of viewing the weight, but one which has the danger of misinterpretation if all of the elements used in the picture are assumed to have reality or are confused with similar elements that occur in our present approximate theories of the world, is the following analogy: Assume that God has His own time (not to be confused with the time that we use in our present approximate physical theories, but having some properties analogous to what we often assume, perhaps erroneously, that time does in our approximate physical theories), and that as He creates each conscious experience, He spends a time  $w(p)$  giving existence to each. In other words, assume that each exists for an amount  $w(p)$  of God's time. Then the conscious experiences with greater  $w(p)$  will have a greater existence in the sense of their duration in God's time. The picture is then that the weight for conscious experiences may be viewed as somewhat analogous to the measure of physical time used for calculating time averages in dynamical systems, for example.

Because the specification of the conscious experience  $p$  completely determines its content and how it is experienced (how it feels), the weight  $w(p)$  has absolutely no effect on that—there is absolutely no way within the experience to sense anything directly of what the weight is. A toothache within a particular conscious experience  $p$  is precisely as painful an experience no matter what  $w(p)$  is. Furthermore, the experience  $p$  is whatever  $p$  is and has absolutely no memory of how long God may have had that experience existing within His time in the analogy. It is just that an experience with a greater  $w(p)$  is more likely in the sense of being more probably chosen by a random selection using the weights  $w(p)$ . (Of course, the experience  $p$  might include a conscious awareness of belief in a theory that assigns a particular weight to that experience, but the awareness of that belief will be part of  $p$  itself and will not directly depend on whether the actual weight is what the believed theory assigns for it. In this way a conscious belief depends only on the conscious experience of which that belief is a part and not on the truth of the implications of that belief. It is only by faith in the orderliness of the universe that we can assume that our conscious orderly beliefs about it are true, and even that faith itself can be regarded to be just given as part of the corresponding conscious experience.)

If one takes the attitude that there is no reality to a divine temporal period  $w(p)$  for the existence of the conscious experience  $p$  (in the analogy that admittedly is rather contrived), and that there is no reality to the random selection with weights proportional to  $w(p)$ , then one might think that the weights have no reality but are merely a meaningless arbitrary assignment. I do find it difficult to try to describe the

weights in terms of anything more basic and of whose existence I am more confident, but I also believe that the weights really are fundamental elements of reality. In other words, I believe that some sets of conscious experiences really do have a greater measure of reality than others, and this greater measure is the explanation of why my present experience has its experienced orderliness: such orderly experiences have greater weight than ones which are much more disorderly. Of course, I cannot prove this assumption, but it enables me to make progress toward finding an explanation of the orderliness that I experience, so I shall continue to make it here.

One technical point that it is now time to make is that to simplify the discussion above, I have often implicitly assumed that the set  $M$  of possible conscious experiences is a countable discrete set, so that, for example, one can imagine choosing an experience  $p$  at random with weight  $w(p)$ . In particular, if the total sum of the weights for all conscious experiences is finite and is normalized to be unity, then the weight  $w(p)$  for each conscious experience is simply the probability for that experience to be chosen by the random selection. This is indeed the possibility that is the easiest to visualize, and it generally will not hurt to have it in mind for most of the discussion below, but in forming a fairly general framework for the connection between the quantum and mental worlds, I would not like to make unnecessary restrictions, and so I shall allow the possibility that the set of conscious experiences may be uncountable or continuous. (Is there a true continuum for the pain of a toothache, or are there only a countable set of discrete values for how painful it can be experienced? We don't know which it is, so I shall allow either possibility.)

If the set  $M$  of conscious experiences is a continuum, then a nonzero weight for a single conscious experience  $p$  (a point in this continuum) is rather meaningless, but in reasonable cases one can still have a weight for any set  $S$  of experiences, even if this weight is zero for any single individual experience. (For even this to be possible, the set  $M$  of all possible experiences must be a measurable set, which I shall continue to assume, since I personally don't know how to make much sense of a generalization in which that is not true.) To give the weight for a set of experiences a fancier name, let us henceforth call it the *measure*  $\mu(S)$  of the subset  $S$  of the full set  $M$  of possible conscious experiences.

Then one can imagine that if exclusive subsets are being selected randomly with the measure  $\mu$ , then the ratio of the probability of choosing  $S_1$ , say, to that of choosing  $S_2$  would be  $\mu(S_1)/\mu(S_2)$ , so the measures for the sets would give their relative probabilities. If  $\mu(M)$  is finite, then one can define a normalized weight  $P(S) = \mu(S)/\mu(M)$  which would be the probability of choosing the subset  $S$  if one randomly selected, with the measure  $\mu$ , among an exhaustive and exclusive set of subsets of  $M$  that includes the subset  $S$ . For example, if  $S_1$  is the set of conscious experiences in which no toothache is felt and  $S_2$  is the set of conscious experiences in which a toothache is felt, then these two subsets of  $M$  form an exhaustive and exclusive set of two subsets of  $M$ , since every conscious experience  $p$  in  $M$  is in  $S_1$  or

$S_2$  (exhaustive subsets), and no experience is in both (exclusive subsets). Therefore,  $\mu(M) = \mu(S_1) + \mu(S_2)$ , and  $P(S_2) = \mu(S_2)/\mu(M)$  is the probability of randomly selecting a conscious experience with a toothache.

However, it might be that the total set  $M$  of conscious experiences is so large, and the measure  $\mu(S)$  for its subsets  $S$  is so widely spread, that the total measure of  $M$  is divergent. (A simple example would be if  $M$  could be put into one-to-one correspondence with the real number line,  $-\infty < x < \infty$ , and if the measure for the set  $S = \{x|x_1 < x < x_2\}$  were  $\mu(S) = x_2 - x_1$ , simply the length of the interval for  $x$ .) Then any subset with finite measure  $\mu(S)$  would have zero absolute probability of being chosen if one divided by the infinite  $\mu(M)$ . Also, even if one chose subsets with infinite measure, dividing that infinity by the infinity of the total measure would generally give ambiguous results, and so absolute probabilities that are not zero would be ambiguous. This might make it hard to test such a theory. However, if one had two subsets with finite measure, say  $S_1$  and  $S_2$ , then one would get a finite conditional probability to be in, say,  $S_1$ , given that one is in the union of the two sets, and so there still might be some tests of such a measure that one could make. Therefore, I am hesitant at this stage to demand that the total measure for the full set  $M$  of all possible conscious experiences be finite.

Now, having explained briefly what I take the basics of quantum theory to be and what it might mean to have a set of conscious experiences with a measure, it is time to write these as axioms and add my axiom for the basic structure of the psycho-physical parallelism.

Mindless Sensationalism (MS) is given by the following three basic postulates or axioms [5]:

**Quantum World Axiom:** The unconscious “quantum world”  $Q$  is completely described by an appropriate algebra of operators and by a suitable state  $\sigma$  (a positive linear functional of the operators) giving the expectation value  $\langle O \rangle \equiv \sigma[O]$  of each operator  $O$ .

**Conscious World Axiom:** The “conscious world”  $M$ , the set of all conscious experiences or perceptions  $p$ , has a fundamental measure  $\mu(S)$  for each subset  $S$  of  $M$ .

**Psycho-Physical Parallelism Axiom:** The measure  $\mu(S)$  for each set  $S$  of conscious experiences is given by the expectation value of a corresponding “awareness operator”  $A(S)$ , a positive-operator-valued (POV) measure, in the state  $\sigma$  of the quantum world:

$$\mu(S) = \langle A(S) \rangle \equiv \sigma[A(S)]. \quad (8)$$

For  $A(S)$  to be a POV measure, it is necessary that  $A(S)$  be zero when  $S$  is the empty set and otherwise be either zero or else a positive operator, which implies that  $\sigma[A(S)] \geq 0$  for all positive linear functionals  $\sigma$ , and it is also necessary that if the set  $S$  is a countable union of disjoint sets  $s_i$ ,  $A(S)$  is the sum of the  $A(s_i)$  when this sum “converges in the weak operator topology” [13]. Then  $\mu(S)$  has the

standard additivity property of a measure.

As essentially mentioned above in my description of what I consider to be the basics of quantum theory, the Quantum World Axiom is here deliberately vague as to the precise nature of the algebra of operators and of the state, because as the details of various quantum theories of the universe are being developed, I do not want the general framework of Sensible Quantum Mechanics at this time to be made too restrictive.

The Psycho-Physical Parallelism Axiom states my assumption of the structure of the ‘psycho-physical laws,’ the laws that presumably give the ‘neural correlates of consciousness.’ This axiom, when combined with the other two, gives what to me seems to be the simplest and most conservative framework for “*bridging* principles that link the physical facts with consciousness” and for stating “the connection at the level of ‘Brain state X produces conscious state Y’ for a vast collection of complex physical states and associated experiences” [12] in language that is consistent with Sydney Coleman’s description [19, 20] of quantum theory as having “NO special measurement process, NO reduction of the wavefunction, NO indeterminacy” (in particular, with a many-experiences variant of Everett’s quantum theory [21, 22], in which measures for sets of conscious experiences are added to the bare unitary quantum theory that Coleman advocates).

The Psycho-Physical Parallelism Axiom is the simplest way I know of connecting the quantum world with the conscious world. One could easily imagine more complicated connections, such as having  $\mu(S)$  be a sum or integral, over the conscious experiences  $p$  in the set  $S$ , of some nonlinear function of the expectation values, say  $m(p)$ , of positive “experience operators”  $E(p)$  depending in the  $p$ ’s [5]. Instead, my Psycho-Physical Parallelism Axiom restricts the functions in the sum or integral to be linear in the expectation values. In short, I am proposing that the psycho-physical parallelism is *linear*.

Of course, the Psycho-Physical Parallelism Axiom, like the Quantum World Axiom, is here also deliberately vague as to the form of the awareness operators  $A(S)$ , because I do not have a detailed theory of consciousness, but only a framework for fitting it with quantum theory. My suggestion is that a theory of consciousness that is not inconsistent with bare quantum theory should be formulated within this framework (unless a better framework can be found, of course). I am also suspicious of any present detailed theory that purports to say precisely under what conditions in the quantum world consciousness occurs, since it seems that we simply don’t know yet. I feel that present detailed theories may be analogous to the cargo cults of the South Pacific after World War II, in which an incorrect theory was adopted, that aircraft with goods would land simply if airfields and towers were built.

Since all sets  $S$  of conscious experiences with  $\mu(S) > 0$  really occur in the framework of Mindless Sensationalism, it is completely deterministic if the quantum state and the  $A(S)$  are determined: there are no random or truly probabilistic elements

in MS. Nevertheless, because the framework has measures for sets of conscious experiences, one can readily use them to calculate quantities that can be interpreted as conditional probabilities. One can consider sets of conscious experiences  $S_1$ ,  $S_2$ , etc., defined in terms of properties of the conscious experiences. For example,  $S_1$  might be the set of conscious experiences in which there is a conscious memory of having tossed a coin one hundred times, and  $S_2$  might be the set of conscious experiences in which there is a conscious memory of getting more than seventy heads. Then one can interpret

$$P(S_2|S_1) \equiv \mu(S_1 \cap S_2)/\mu(S_1) \quad (9)$$

as the conditional probability that the conscious experience is in the set  $S_2$ , given that it is in the set  $S_1$ . In our example, this would be the conditional probability that a conscious experience included a conscious memory of getting more than seventy heads, given that it included a conscious memory of having tossed a coin one hundred times.

An analogue of this conditional “probability” is the conditional probability that a person at the beginning of the 21st century is the Queen of England. If we consider a model of all the six billion people, including the Queen, that we agree to consider as living humans on Earth at the beginning of 2001, then at the basic level of this model the Queen certainly exists in it; there is nothing random or probabilistic about her *existence*. But if the model weights each of the six billion people equally, then one can in a manner of speaking say that the conditional probability that one of these persons is the Queen is somewhat less than  $2 \times 10^{-10}$ . I.e., if one chooses at random one of the six billion people on Earth at the beginning of 2001, with each person being assigned an equal probability of being chosen, then the probability of *getting* the Queen by this random selection is, to one-digit accuracy,  $2 \times 10^{-10}$ . (One can see that this probability of getting the Queen would be much more if one instead weighted the probability for each person by the weight of his or her crown, which would be analogous to having a different quantum state giving a different  $\mu(S) = \langle A(S) \rangle$ .) I am proposing that it is in the same manner of speaking that one can assign conditional probabilities to sets of conscious experiences, even though there is nothing truly random about them at the basic level.

As it is defined by the three basic axioms above, Mindless Sensationalism is a framework and not a complete theory for the universe, since it would need to be completed by giving the detailed algebra of operators and state of the quantum world, the set of all possible conscious experiences of the conscious world, and the awareness operators  $A(S)$  for the subsets of possible conscious experiences, whose quantum expectation values are the measures for these subsets.

Furthermore, even if such a complete theory were found, it would not necessarily be the final theory of the universe, since one would like to systematize the connection between the elements given above. As Chalmers eloquently puts it on pages 214-15 of his book [12], “An ultimate theory will not leave the connection at the level of



‘Brain state X produces conscious state Y’ for a vast collection of complex physical states and associated experiences. Instead, it will systematize this connection via an underlying explanatory framework, specifying simple underlying laws in virtue of which the connection holds. Physics does not content itself with being a mere mass of observations about the positions, velocities, and charges of various objects at various times; it systematizes these observations and shows how they are consequences of underlying laws, where the underlying laws are as simple and as powerful as possible. The same should hold of a theory of consciousness. We should seek to explain the supervenience of consciousness upon the physical in terms of the simplest possible set of laws.

“Ultimately, we will wish for a set of *fundamental laws*. Physicists seek a set of basic laws simple enough that one might write them on the front of a T-shirt; in a theory of consciousness, we should expect the same thing. In both cases, we are questing for the basic structure of the universe, and we have good reason to believe that the basic structure has a remarkable simplicity. The discovery of fundamental laws may be a distant goal, however. . . .

“When we finally have fundamental theories of physics and consciousness in hand, we may have what truly counts as a theory of everything. The fundamental physical laws will explain the character of physical processes; the psychophysical laws will explain the conscious experiences that are associated; and everything else will be a consequence.”

Returning to the elements above of a postulated completed, but not necessarily final, Mindless Sensationalism theory, it is presently premature to try to give these elements precisely, particularly the awareness operators that have generally been left out of physics discussions. However, one might give a crude discussion of what they might be like in some highly approximate way.

One very strong assumption that might possibly be plausible for certain quantum theories, is what I have called the Orthogonal Projection Hypothesis [5]. In the terms of the present paper, this implies that the awareness operators  $A(S)$  are projection operators, say  $\Pi(S)$  (operators which remain the same when multiplied by themselves:  $\Pi\Pi = \Pi$ , which implies that the eigenvalues of the operator are either zero or one), and that the awareness operators for two disjoint sets of conscious experiences, say  $S_1$  and  $S_2$ , are orthogonal, so  $A(S_1)A(S_2) = A(S_2)A(S_1) = 0$ . (I should say that I see several reasons for doubting that this very strong Commuting Projection Hypothesis is really plausible as a precise condition on the awareness operators, so I am not advocating this assumption as the final word, but it might be approximately true at least for certain sets  $S$  of conscious experiences, and it does lead to various simple consequences.)

A projection operator corresponds to a corresponding property that a state may have with certainty (if it is an eigenstate of that operator with unit eigenvalue) or that a state may be certain not to have (if it is an eigenstate of that operator with

zero eigenvalue). For a given projection operator, a generic state is not an eigenstate and so is not considered with certainty either to have the property or not to have it. This is an expression of what is often considered the uncertainty of quantum theory, though I would just regard it as a limitation on what “certain” properties a system has.

In the Copenhagen version of quantum theory, to which I do not subscribe except in a very rough instrumentalist sense, a ‘measurement’ is assumed to cause a normalized quantum state to change or ‘collapse’ to another quantum state given by applying a projection operator to the original state and then renormalizing its magnitude. The expectation value of the projection operator,  $P = \langle \Pi \rangle$  in the original state, is then interpreted as the probability that that state will thus collapse, effectively giving a “yes” answer to the question posed by the measurement of whether the system being measured has the property corresponding to the projection operator  $\Pi$ . ( $1 - P = \langle (I - \Pi) \rangle$  is then the probability that the answer will be “no,” so that the state will instead collapse to the other possibility, which is that given by applying the complementary projection operator  $I - \Pi$  to the original state and renormalizing it—here  $I$  is the identity operator that leaves a state the same.) The fact that  $\Pi$  is a projection operator means that if the state collapsed to the “yes” answer, a second measurement of precisely the same property would with certainty give the answer “yes” again, so that after the state collapses the first time, to an eigenstate of the projection operator with unit eigenvalue, the property corresponding to the projection operator will with certainty be true.

To illustrate projection operators, return to the example of a single nonrelativistic particle moving along the  $x$  axis, with its quantum state represented by a wavefunction  $\psi(x)$  which is normalized so that the integral of  $|\psi(x)|^2$  over all  $x$  is unity. In this case a simple example of a projection operator  $\Pi$  is one which determines whether the particle is in some range of  $x$ , say the range  $x > 0$ . The expectation value of this is then  $P$ , the integral of  $|\psi(x)|^2$  over all positive  $x$ , and if the quantum state collapses to this possibility in the Copenhagen version of quantum theory, the wavefunction would change to  $\psi(x)/\sqrt{P}$  for  $x > 0$  and to 0 for  $x < 0$ , effectively giving a “yes” answer to the measurement determination of whether the particle was to the right of the origin. On the other hand, if the answer is “no,” which would occur with a probability  $1 - P$ , the wavefunction would change to 0 for  $x > 0$  and to  $\psi(x)/\sqrt{1 - P}$  for  $x < 0$ . This change is known as the ‘collapse of the wavefunction’ or the ‘reduction of the quantum state.’

In my Mindless Sensationalism, the quantum state of the universe never changes by any collapse or reduction mechanism. However, if the awareness operator  $A(S)$  for a certain set of conscious experiences is a projection operator  $\Pi$ , and if the quantum state is normalized so that the expectation value of the unit operator  $I$  is unity, then  $\mu(S) = \langle A(S) \rangle = \langle \Pi \rangle = P$ , the same as the probability in the Copenhagen version of quantum theory that measuring the property corresponding to  $\Pi$  would give a

“yes” answer.

For example, it is tempting to suppose that if the set of conscious experiences is a set of very similar experiences (or perhaps just a single experience if the set of possible experiences is countably discrete) that would occur for a person having a particular brain configuration, then  $A(S)$  is approximately a projection operator onto those brain configurations. In this case, the measure  $\mu(S)$  for those experiences would then be the same as the probability for the corresponding brain configurations in Copenhagen quantum theory.

The Orthogonal Projection Hypothesis appears to be a specific mathematical realization of part of Lockwood’s proposal [7] (p. 215), that “a phenomenal perspective [what I have here been usually calling a conscious experience  $p$ ] may be equated with a shared eigenstate of some preferred (by consciousness) set of compatible brain observables.” Here I have expressed the “equating” by my Quantum-Consciousness Connection Axiom, and presumably the “shared eigenstate” can be expressed by a corresponding projection operator  $\Pi$ .

Or, as Lockwood has expressed it in this present volume [4], “I am suggesting, in other words, that the contents of consciousness, at any given moment, correspond to a set of measurement outcomes that belong to the respective spectra of a compatible set of observables on the mind, construed as a subsystem of the brain.” If this suggestion is incorporated within my axioms, it effectively assumes that the awareness operators corresponding to sets of conscious experiences “at any given moment” obey the Orthogonal Projection Hypothesis. However, in my axioms I do not need a definition of what “at any given moment” might mean, and I do not need to be able to define the mind as a subsystem of the brain; for me the awareness operators  $A(S)$  are basic. (I also do not need the Orthogonal Projection Hypothesis, though for now it is interesting to examine the consequences if it were true.)

I should also emphasize that if the same conscious experience is produced by several different orthogonal “eigenstates of consciousness” (e.g., different states of a brain and surroundings that give rise to the same conscious experience  $p$ ), then in the Orthogonal Projection Hypothesis the projection operator  $\Pi$  would be a sum of the corresponding rank-one projection operators and so would be a projection operator of rank higher than unity. This is what I would expect, since surely the surroundings could be different and yet the appropriate part of the brain, if unchanged, would lead to the same experience. As Lockwood has put it [4], “In particular, the contents of consciousness would seem to be highly *coarse-grained*, in relation to the immensely intricate physical processes on which they ostensibly supervene. This difficulty for materialism was taken very seriously by the philosopher Wilfred Sellars [23], who dubbed it the ‘grain problem’. ... Crucially, I also assume that the compatible set of observables, corresponding eigenvalues of which jointly define a given state of consciousness, is a less than *complete* set. A complete compatible set of observables is one that, when measured, yields *maximal information* concerning the measured

system—information that cannot be improved on by adding further observables to the set. This relates directly to the grain problem. Only by allowing the operative compatible sets of observables to be *incomplete* can we ratchet down the degree of resolution and complexity of the corresponding conscious state to what one would intuitively judge to be the right level.”

On the other hand, if  $A(S)$  were a sum of noncommuting projection operators, or even a sum of commuting projection operators that are not orthogonal, or if it were a weighted sum of orthogonal projection operators with weights different from unity, then generically  $A(S)$  would not be a projection operator  $\Pi$  as assumed in the Orthogonal Projection Hypothesis. Although it would mean that the situation would not be so simple as one (e.g., Lockwood, or I in an optimistic moment) might like to assume, I see no fundamental difficulty in having the awareness operators not be projection operators and not be orthogonal.

There are many other alternative technical assumptions that one might make about the awareness operators [5], but I shall not discuss them further here.

Another point I should emphasize is that in Mindless Sensationalism, there is no fundamental notion of a correlation between distinct conscious experiences. One can get the measure (and the normalized probability, if the total measure for the set  $M$  of all conscious experiences is finite) for any set  $S$  of experiences, but one does not get any nontrivial fundamental formula for the joint occurrence of distinct experiences. In particular, there does not seem to be any fundamental formula for the conditional probability of one set  $S$  of experiences given a second set  $S'$  that is exclusively distinct, having no elements in common with the first set  $S$  (other than the formula for the basic probability  $P(S)$  of the first set, the trivial conditional probability). This essentially fits the crudely-expressed fact that by the definition of a conscious experience  $p$ , a “conscious being” can be directly aware of only “one at a time.” From the memory components of a “present” experience, one might postulate the existence of a “past” experience in which what is now just remembered is at that “past” “time” then experienced as occurring simultaneously with the “past” experience itself when that experience was being experienced. However, within one’s present experience, one has no direct experience of the past experience itself. Correspondingly, within my framework of Mindless Sensationalism, there is no fundamental way to assign a probability of a “past” experience given a particular present one. Instead, each experience (if countably discrete, or else each set of experiences if one must combine a continuum of them to get a nonzero measure  $\mu(S)$ ) has its own measure, which is independent of the realization of any other experiences.

In the other direction of “time,” Mindless Sensationalism does not assign any fundamental conditional probabilities to any “future” experiences given the existence of a particular present one. One might think that it should, since it is just common sense that probabilities for the future depend upon present conditions. For example, in Copenhagen quantum theory, if the quantum state of the universe collapses to,

say, an eigenstate with unit eigenvalue of one of a particular  $A(S)$  that is, say, a projection operator  $\Pi$ , then one expects that the probabilities of future conscious experiences will depend upon which  $A(S)$  the quantum state collapsed to. If the quantum state collapses to an eigenstate of the assumed projection operator in which you are aware of winning a large lottery, one would expect that a month later, the probability that you would experience an awareness of having a lot of money would be greater than if the quantum state collapsed to an eigenstate in which you were not aware of winning any large lottery (assuming that you would not spend most of the money within the month).

However, in Mindless Sensationalism, the measure or probability of any “future” conscious experience is completely determined by the (full) theory and is independent of the occurrence of any “present” conscious experience. This sounds absurd. How can it be reconciled with our experience? I am aware of having a computer in front of me; isn’t this correlated with my past awareness of buying a computer?

The answer is that this experience does not show any correlations between different experiences (e.g., between those at different “times”) but rather the correlations between the different components of a single present experience (e.g., of perceiving a visual image of a computer screen and of being consciously aware of a memory of buying the computer). These are the correlations to be explained by a full theory of Mindless Sensationalism. (I’m just giving the framework here; the full theory will involve an enormous amount of work, and I suspect that humans will never completely develop it, though I hope they will learn a lot more about it than the pittance we know now, and perhaps even develop an approximate outline of it.)

Similarly, a prediction of what might seem to be a correlation between a “present” awareness of winning a large lottery and a “future” awareness of having a lot of money is, I would claim, not that at all, but rather a prediction of a correlation between one’s “future” awareness of having a lot of money and, within the same conscious experience, a conscious awareness of a memory of having won a large lottery.

To give another example, I can predict that if you are consciously aware of reading this paper today (i.e., if you are not reading it in a daze, with no conscious awareness of what you are doing, though I am not claiming that reading it unconsciously is impossible or even that this possible experience is uncorrelated with the content of this paper), you will consciously remember my phrase “Mindless Sensationalism” tomorrow if you think about my paper then. Am I predicting something about your experience tomorrow that is conditional upon your experience today? No. I am just predicting that in your conscious experience of remembering reading this prediction of mine the day before, within the same conscious experience there will be a reasonably high probability that you will also be aware of my phrase “Mindless Sensationalism.”

The fundamental timelessness of Mindless Sensationalism seems to fit very well

with the viewpoint eloquently expressed by Julian Barbour [24], that “Heraclitan flux . . . may well be nothing but a well-founded illusion.” (I might note that although I almost entirely agree with what Barbour writes, I am perhaps not quite such as extreme anti-temporalist in that I suspect that the quantum state of the universe may be given by a path integral that has something analogous to histories in them, even though I agree with Barbour that the universe fundamentally does not have anything like a classical history or classical time. I think Barbour would also agree with me that there are no fundamental sequences of conscious experiences.)

In saying that Mindless Sensationalism posits no fundamental correlation between complete conscious experiences, I do not mean that it is impossible to define such correlations from the mathematics, but only that I do not see any fundamental physical meaning for such mathematically-defined correlations. As an example of how such a correlation might be defined, consider that if an awareness operator  $A(S)$  is a projection operator, and the quantum state of the universe is represented by the pure state  $|\psi\rangle$ , one can ascribe to the set of conscious experiences  $S$  the pure Everett “relative state” [21, 22]

$$|S\rangle = \frac{A(S)|\psi\rangle}{\|A(S)|\psi\rangle\|} = \frac{A(S)|\psi\rangle}{\langle\psi|A(S)A(S)|\psi\rangle^{1/2}}. \quad (10)$$

Alternatively, if the quantum state of the universe is represented by the density matrix  $\rho$ , one can associate the set of experiences  $S$  with a relative density matrix

$$\rho_S = \frac{A(S)\rho A(S)}{\text{Tr}[A(S)\rho A(S)]}. \quad (11)$$

Either of these formulas can be applied when the awareness operator  $A(S)$  is not a projection operator, but then the meaning is not necessarily so clear.

Then if one is willing to say that  $\text{Tr}[A(S)\rho]$  is the absolute probability for the set of experiences  $S$  (which might seem natural at least when  $A(S)$  is a projection operator, though I am certainly not advocating this naïve interpretation, and in general it will not agree in absolute magnitude with  $P(S) = \mu(S)/\mu(M)$ ), one might also naïvely interpret  $\text{Tr}[A(S')\rho_S]$  as the conditional probability of the set of experiences  $S'$  given the set of experiences  $S$ .

Another thing one can do with two sets of experience  $S$  and  $S'$  is to calculate an “overlap fraction” between them as

$$f(S, S') = \frac{\langle A(S)A(S') \rangle \langle A(S')A(S) \rangle}{\langle A(S)A(S) \rangle \langle A(S')A(S') \rangle}. \quad (12)$$

If the quantum state of the universe is pure, this is the same as the overlap probability between the two Everett relative states corresponding to the two sets of experiences:  $f(S, S') = |\langle S|S'\rangle|^2$ . Thus one might in some sense say that if  $f(S, S')$  is near unity, the two sets of experiences are in nearly the same one of the Everett “many worlds,” but if  $f(S, S')$  is near zero, the two conscious experiences are

in nearly orthogonal different worlds. However, this is just a manner of speaking, since I do not wish to say that the quantum state of the universe is really divided up into many different worlds. In a slightly different way of putting it, one might also propose that  $f(S, S')$ , instead of  $\text{Tr}[A(S')\rho_S]$ , be interpreted as the conditional probability of the set of experiences  $S'$  given the set of experiences  $S$ . Still, I do not see any evidence that  $f(S, S')$  should be interpreted as a fundamental element of Mindless Sensationalism. In any case, one can be conscious only of a single conscious experience at once, so there is no way in principle that one can test any properties of joint sets of conscious experiences such as  $f(S, S')$ .

An amusing property of both of these ad hoc “conditional probabilities” for one conscious experience given another is that they would both always be zero if the Orthogonal Projection Hypothesis were true. Even though the resulting theory would generally be a “many-experiences” theory, it could be interpreted as being rather solipsistic in the sense that in the relative density matrix  $\rho_p$  corresponding to my present conscious experience  $p$ , no other disjoint set conscious experiences would occur in it with nonzero measure! This has the appearance of being somewhat unpalatable, and might be taken to be an argument against adopting the Orthogonal Projection Hypothesis, but it is not clear to me that this is actually strong evidence against the Orthogonal Projection Hypothesis.

In addition to the fact that Mindless Sensationalism postulates no fundamental notion of any *correlation* between individual conscious experiences, it also postulates no fundamental *equivalence* relation on the set of conscious experiences. For example, the measure gives no way of classifying different conscious experiences as to whether they belong to the same conscious being (e.g., at different times) or to different conscious beings. The most reasonable such classification would seem to be by the content (including the *qualia*) of the conscious experiences themselves, which distinguish the conscious experiences, so that no two different conscious experiences,  $p \neq p'$ , have the same content. Based upon my own present conscious experience, I find it natural to suppose that conscious experiences that could be put into the classification of being alert human experiences have such enormous structure that they could easily distinguish between all of the  $10^{11}$  or so persons that are typically assigned to our history of the human race. In other words, in practice, different people can presumably be distinguished by their conscious experiences.

Another classification of conscious experiences might be given by classifying the awareness operators  $A(S)$  rather than the content of the conscious experiences themselves. This would be more analogous to classifying people by the quantum nature of their bodies (in particular, presumably by the characteristics of the relevant parts of their brains). However, I doubt that in a fundamental sense there is any absolute classification that uniquely distinguishes each person in all circumstances. (Of course, one could presumably raise this criticism about the classification of any physical object, such as a “chair” or even a “proton”: precisely what projection

operators correspond to the existence of a “chair” or of a “proton”?) Therefore, in the present framework conscious experiences are fundamental, but persons (or individual minds), like other physical objects, are not, although they certainly do seem to be very good approximate entities (perhaps as good as chairs or even protons) that I do not wish to deny. Even if there is no absolute definition of persons in the framework of Mindless Sensationalism itself, the concept of persons and minds does occur in some sense as part of the *content* of my present conscious experience, just the concepts of chairs and of protons do (in what are perhaps slightly different “present conscious experiences,” since I am not quite sure that I can be consciously aware of all three concepts at once, though I seem to be aware that I have been thinking of three concepts).

In this way the framework of Mindless Sensationalism proposed here is a particular manifestation of Hume’s ideas [25], that “what we call a *mind*, is nothing but a heap or collection of different perceptions, united together by certain relations, and suppos’d, tho’ falsely, to be endow’d with a perfect simplicity and identity” (p. 207), and that the self is “nothing but a bundle or collection of different perceptions” (p. 252). As he explains in the Appendix (p. 634), “When I turn my reflexion on *myself*, I never can perceive this *self* without some one or more perceptions; nor can I ever perceive any thing but the perceptions. ’Tis the composition of these, therefore, which forms the self.” (Here I should note that what Hume calls a perception may be only one *component* of the “phenomenal perspective” or “maximal experience” [7] that I have been calling a perception or conscious experience  $p$ , so one of my  $p$ ’s can include “one or more perceptions” in Hume’s sense.)

Furthermore, each awareness operator  $A(S)$  need not have any precise location in either space or time associated with it, so there need be no fundamental place or time connected with each conscious experience. Indeed, Mindless Sensationalism can easily survive a replacement of spacetime with some other structure (e.g., superstrings) as more basic in the quantum world. Of course, the *contents* of a conscious experience can include a sense or impression of the time of the conscious experience, just as my present conscious experience when I perceive that I am writing this includes a feeling that it is now A.D. 2001, so the set of conscious experiences  $p$  must include conscious experiences with such beliefs, but there need not be any precise time in the physical world associated with a conscious experience. That is, conscious experiences are ‘outside’ physical spacetime (even if spacetime is a fundamental element of the physical world, which I doubt).

As a consequence of these considerations, there are no unique time-sequences of conscious experiences to form an individual mind or self in Mindless Sensationalism. In this way the present framework appears to differ from those proposed by Squires [26], Albert and Loewer [10, 11], and Stapp [27]. (Stapp’s also differs in having the wavefunction collapse at each “Heisenberg actual event,” whereas the other two agree with mine in having a fixed quantum state, in the Heisenberg picture, which



never collapses.) Lockwood’s proposal [7] seems to be more similar to mine, though he also proposes (p. 232) “a continuous infinity of parallel such streams” of consciousness, “*differentiating* over time,” whereas Sensible Quantum Mechanics has no such stream as fundamental. On the other hand, later Lockwood [8] does explicitly repudiate the Albert-Loewer many-minds interpretation, so there seems to me to be little disagreement between Lockwood’s view and Mindless Sensationalism except for the detailed formalism and manner of presentation. Thus one might label Mindless Sensationalism as the Hume-Everett-Lockwood-Page (HELP) interpretation, though I do not wish to imply that these other three scholars, on whose work my proposal is heavily based, would necessarily agree with my present formulation, which certainly is not contained in explicit detail in what they have written.

Of course, the conscious experiences themselves can include components that seem to be memories of past conscious experiences or events. In this way it can be a very good approximation to give an approximate order for conscious experiences whose content include memories that are correlated with the contents of other conscious experiences. It might indeed be that the measure for conscious experiences including detailed memories is rather heavily peaked around approximate sequences constructed in this way. But I would doubt that the contents of the conscious experiences  $p$ , the awareness operators  $A(S)$ , or the measures  $\mu(S)$  for the sets of conscious experiences  $S$  would give unique sequences of conscious experiences that one could rigorously identify with individual minds.

Because the physical state of our universe seems to obey the second law of thermodynamics, with growing correlations in some sense, I suspect that the measure may have rather a smeared peak (or better, ridge) along approximately tree-like structures of branching sequences of conscious experiences, with conscious experiences further out along the branches having contents that includes memories that are correlated with the present-sensation components of conscious experiences further back toward the trunks of the trees. This is different from what one might expect from a classical model with a discrete number of conscious beings, each of which might be expected to have a unique sharp sequence or non-branching trajectory of conscious experiences. In the quantum case, I would expect that what are crudely viewed as quantum choices would cause smeared-out trajectories to branch into larger numbers of smeared-out trajectories with the progression of what we call time. If each smeared-out trajectory is viewed as a different individual mind, we do get roughly a “many-minds” picture that is analogous to the “many-worlds” interpretation [21, 22], but in my framework of Mindless Sensationalism, the “many minds” are only approximate and are not fundamental as they are in the proposal of Albert and Loewer [10]. Instead, Mindless Sensationalism is a “many-experiences” or “many-sensations” interpretation.

Even in a classical model, if there is one conscious experience for each conscious being at each moment of time in which the being is conscious, the fact that there

may be many conscious beings, and many conscious moments, can be said to lead to a “many-experiences” interpretation. However, in Mindless Sensationalism, there may be vastly more conscious experiences, since they are not limited to a discrete set of one-parameter sharp sequences of conscious experiences, but occur for all sets of conscious experiences  $S$  for which  $A(S)$  is positive. In this way a quantum model may be said to be even “more sensible” (or is it “more sensational”?) than a classical model. One might distinguish MS from a classical model with many conscious experiences by calling MS a “very-many-experiences” framework, meaning that almost all sets of possible conscious experiences actually occur with nonzero measure. (Thus MS might, in a narrowly literal sense, almost be a version of panpsychism, but the enormous range possible for the logarithm of the measure means that it is really quite far from the usual connotations ascribed to panpsychism. This is perhaps comparable to noting that there may be a nonzero amplitude that almost any system, such as a star, has a personal computer in it, and then calling the resulting many-worlds theory pancomputerism.)

One might fear that the present attack on the assumption of any definite notion of a precise identity for persons or minds as sequences of conscious experiences would threaten human dignity. Although I would not deny that I feel that it might, I can point out that on the other hand, the acceptance of the viewpoint of Mindless Sensationalism might increase one’s sense of identity with all other humans and other conscious beings. Furthermore, it might tend to undercut the motivations toward selfishness that I perceive in myself if I could realize in a deeply psychological way that what I normally anticipate as my own future conscious experiences are in no fundamental way picked out from the set of all conscious experiences. (Of course, what I normally think of as my own future conscious experiences are presumably those that contain memory components that are correlated with the content of my present conscious experience, but I do not see logically why I should be much more concerned about trying to make such conscious experiences happy than about trying to make conscious experiences happy that do not have such memories: better to do unto others as I would wish they would do unto me.) One can find that Parfit [28] had earlier drawn similar, but much more sophisticated, conclusions from a view in which a unique personal identity is not fundamental.

The framework of Mindless Sensationalism can suggest various questions, methods of analysis, and speculations that might not occur to one using other frameworks. I have done an analysis [5] of the Einstein-Podolsky-Rosen (EPR) “paradox” [29] combined with that of Schrödinger’s cat [30], finding that if the components of one’s awareness are correlated with different physical properties that are highly correlated (such as whether different parts of a cat are alive or dead), then one can indeed predict that one’s conscious experience will have components that are highly correlated. E.g., when one looks at the different parts of Schrödinger’s cat, one will tend to have a strong agreement between the components of the awareness of the

different parts of the cat's body as to whether the cat is dead or alive, if indeed the actual awareness operators cause one to be aware of whether each part of the cat is dead or alive. (If instead one were aware of whether each part of the cat were in the symmetric or antisymmetric linear superposition of being alive or dead, one would not have much agreement between the components of the awareness of the separate parts as to whether they were in the symmetric or antisymmetric states.)

However, it still leaves it mysterious as to why we seem to be aware of the properties that are highly correlated (such as whether the different parts of a cat are dead or alive), rather than of properties that are not highly correlated (such as whether the different parts of a cat are in the symmetric or antisymmetric superpositions of being dead or alive). In other words, it still is somewhat confusing to me why in idealized cases our conscious experiences actually seem to be rather unconfused. One might argue that if they were not unconfused, then we could not act coherently and so would not survive. This would seem to be a good argument only if our conscious experiences really do affect our actions in the quantum world and are not just epiphenomena that are determined by the quantum world without having any effect back on it. But on the other hand, it is not obvious how conscious experiences could affect the quantum world in a relatively simple way in detail (though it is easy to speculate on general ways in which there might be some effect; see [6] and below). So although it appears to be unexplained, it conceivably could be that conscious experiences do not affect the quantum world but are determined by it in just such a way that in most cases they are not too confused. To mimic Einstein, I am tempted to say, "The most confusing thing about conscious experiences is that they are generally unconfused."

As an aside, I should say that although epiphenomenalism seems to leave it mysterious *why* typical conscious experiences are unconfused, I do not think it leaves it mysterious *that* conscious experiences occur, despite a naïve expectation that the latter is also mysterious. The naïve argument is that if the conscious world has no effect on the quantum world (usually called the physical world [31, 12], in contrast to my use of that term to include both the quantum world and the conscious world), and if the development of life in the quantum world occurs by natural selection, the development of consciousness would have no effect on this natural selection and so could not be explained by it.

Nevertheless, one can give an answer analogous to what I have heard was given by the late Fermilab Director Robert Wilson when he was asked by a Congressional committee what Fermilab contributed to the defense of the nation: "Nothing. But it helps make the nation worth defending." Similarly, if epiphenomenalism is correct, consciousness may contribute nothing to the survival of the species, but it may help make certain species worth surviving. More accurately, it may not contribute to the evolution of complexity, but it may select us (probably not uniquely) as complex organisms which have typical conscious experiences. Then our consciousness would

not be surprising, because we are selected simply as typical conscious beings.

This selection as typical conscious beings might also help explain why we can do highly abstract theoretical mathematics and physics that does not seem to help us much with our survival as a species. If we are selected by the measure of our consciousness, and if that is positively correlated with a certain kind of complexity that is itself correlated with the ability to do theoretical mathematics and physics, then it would not be surprising that we can do this better than the average hominid that survives as well as we do (say averaging over all the Everett many worlds).

Another question one might ask within the context of Mindless Sensationalism is whether and how the measures of the sets of conscious experiences associated with an individual brain depend on the brain characteristics. One might speculate that it might be greater for brains that are in some sense more intelligent, so that in a crude sense brighter brains have a bigger measure of conscious experiences. This could explain why you do not perceive yourself to be an insect, for example, even though there are far more insects than humans.

One might also be tempted to use this speculation to explain why you may consider yourself to be more intelligent than the average human (though another possible explanation is that it is likely that the average person considers himself brighter than average). However, in this case the statistical evidence, if present at all, is almost certainly much weaker than in the case of comparing ourselves with ants. Therefore, this speculation should not be used to justify any politically incorrect conclusions that one might be tempted to make from an assumption that he or she has a greater measure of consciousness than most other humans.

Also, one might conjecture that an appropriate measure on conscious experiences might give a possible explanation of why most of us perceive ourselves to be living on the same planet on which our species developed. This observation might seem surprising when one considers that we may be technologically near the point at which we could leave Earth and colonize large regions of the Galaxy [32], presumably greatly increasing the number of humans beyond the roughly  $10^{11}$  that are believed to have lived on Earth. If so, why don't we have the conscious experiences of one of the vast numbers of humans that may be born away from Earth? One answer is that some sort of doom is likely to prevent this vast colonization of the Galaxy from happening [33, 34, 35, 36], though these arguments are not conclusive [37]. Although I would not be surprised if such a doom were likely, I would naïvely expect it to be not so overwhelmingly probable that the probability of vast colonization would be so small as is the presumably very small ratio of the total number of humans who could ever live on Earth to those who could live throughout the Galaxy if the colonization occurs. Then, even though the colonization may be unlikely, I would expect that it should still produce a higher measure for conscious experiences of humans living off Earth than on it.

However, another possibility is that colonization of the Galaxy is not too improb-

able, but that it is mostly done by self-replicating computers or machines who do not tolerate many humans going along, so that the number of actual human colonizers is not nearly so large as the total number who *could* live throughout the Galaxy if the computers or machines did not dominate the colonization. If the number of these computers or machines dominate humans as “intelligent” beings (in the sense of having certain information-processing capabilities), one might still have the question of why we perceive ourselves as being humans rather than as being one of the vastly greater numbers of such machines. But the explanation might simply be that the *measure* of conscious experiences is dominated by human conscious experiences, even if the *number* of “intelligent” beings is not. In other words, human brains may be much more efficient in producing conscious experiences than the kinds of self-replicating computers or machines which may be likely to dominate the colonization of the Galaxy. If such machines are more “intelligent” than humans in terms of information-processing capabilities and yet are less efficient in producing conscious experiences, our conscious experiences of being human would suggest that the measure of conscious experiences is not merely correlated with “intelligence.” (On the other hand, if the measure of conscious experiences is indeed strongly correlated with “intelligence” in the sense of information-processing capabilities, perhaps it might be the case that Galactic colonization is most efficiently done by self-replicating computers or machines that are not so “intelligent” as humans. After all, insects and even bacteria have been more efficient in colonizing a larger fraction of Earth than have humans.)

It might be tempting to take the observations that these speculations might explain (our conscious experiences of ourselves as human rather than as insect, and our experiences of ourselves as humans on our home planet) as evidence tending to support the speculations. One could summarize such reasoning as a generalization of the Weak Anthropic Principle [38, 39, 40, 41, 42, 43, 44] that might be called the *Conditional Aesthemic Principle* (CAP, not entirely coincidentally the initials of my wife Cathy Anne): given that we are conscious beings, our conscious experiences are likely to be typical experiences in the conscious world with its measure.

Another use for the framework of Mindless Sensationalism would be to see how various general approaches to the problems of consciousness can be expressed in terms that are compatible (in the way I have suggested) with quantum theory. I have personally read so little of these approaches (fewer books than I have fingers) that I am not competent to try to see how to do that. However, I must admit that from what little I have read of, say functionalism, and from my mental attempts to translate what I have read into the language of my Mindless Sensationalism, I am confused as to precisely how functionalism would be expressed.

Functionalism is supposed to be “the view that mental states are defined by their causes and effects” [45]. If a particular “mental state” is to be identified with a particular conscious experience  $p$ , then I am not clear what its “causes and effects”

are supposed to be. Although I have no idea what the “effects” of  $p$  are supposed to be, I suppose that in one sense one could say that its causes are both the experience operator  $E(p)$  (the  $p$ -dependent operator whose sum or integral over the  $p$ ’s in the set  $S$  gives the corresponding awareness operator  $A(S)$ ) and the quantum state of the universe,  $\sigma$ , since both enter into the equation  $m(p) = \sigma[E(p)]$  for the weight  $m(p)$  that is summed or integrated over the conscious experiences in a set  $S$  to give the measure  $\mu(S)$  for that set. If this interpretation of functionalism were correct, a consequence for the conjecture of functionalism would be that no two distinct conscious experiences, say  $p$  and  $p'$ , have the same experience operators: If  $p \neq p'$ , then  $E(p) \neq E(p')$ . Equivalently, if  $E(p) = E(p')$ , then  $p = p'$ . This is certainly a plausible conjecture, but I see no way to justify it or test whether or not it is true, though I believe that it is a conjecture with real content and logically could be either true or false.

Another interpretation might be to identify a “mental state” with a quantum state that gives rise to a particular conscious experience  $p$ . If any state  $\sigma$  that gives  $m(p) = \sigma[E(p)] > 0$  is counted as a “mental state” that “gives rise” to  $p$ , then all but a set of measure zero of possible quantum states  $\sigma$  could be said to “give rise” to  $p$ . This seems far too broad, so let us see whether we can get a narrower class of quantum states that “give rise” to  $p$ .

One way is to consider what different quantum states can be considered to contribute “directly” to a conscious experience  $p$ . If, for a given conscious experience  $p$ , the corresponding experience operator  $E(p)$  were decomposed into a weighted sum of orthogonal rank-one projection operators  $\Pi_i$ ,

$$E(p) = \sum_i W_i \Pi_i \quad (13)$$

with positive weights  $W_i$ , then the eigenstate  $|\psi_i\rangle$  with unit eigenvalue of each of these projection operators  $\Pi_i$  (the state which when written in the form  $|\psi_i\rangle\langle\psi_i|$  is identical to the rank-one projection operator  $\Pi_i$ ) would give a contribution to the measure for the conscious experience  $p$ . In a sense one can say that it is each of these eigenstates (one for each rank-one projection operator that occurs in Eq. (13)) that *directly* gives rise to the conscious experience  $p$ . (Of course, any state  $\sigma$  that is not orthogonal to all of these eigenstates will give a positive weight for the the conscious experience  $p$ ,

$$m(p) = \langle E(p) \rangle = \sum_i W_i \sigma[\Pi_i] \quad (14)$$

the weighted sum of the overlaps of the state  $\sigma$  with the eigenstates  $\Pi_i = |\psi_i\rangle\langle\psi_i|$ . But it is the eigenstates themselves that can be considered to be most directly related to the conscious experience  $p$ .)

So if the “mental states” corresponding to the conscious experience  $p$  are defined to be the eigenstates  $\Pi_i$  that occur in the sum given by Eq. (13), then we can ask

what the “causes and effects” of these are. If an answer to that could be found, perhaps the conjecture of functionalism might be that any two “mental states”  $\Pi_i$  corresponding to the same conscious experience  $p$  would have the same “causes and effects.” Or it might be the converse, that for any “mental state”  $\Pi_i$  that occurs in the sum given by Eq. (13)), any other rank-one projection operator with the same “causes and effects” also occur in that sum. Either of these two conjectures seems to have nontrivial content, but precisely what that content would be depends upon what “having the same causes and effects” is taken to mean. Without an understanding of that, my attempt to guess precisely what functionalism might mean remain stymied.

Therefore, it would be interesting indeed to see how functionalism might possibly be expressed in terms of the operators  $E(p)$  and  $A(S)$  that occur in Mindless Sensationalism.

I have used the example of functionalism not merely to express my own confusion (which might be merely due to my gross ignorance of the field), but also to illustrate that if one can translate conjectures from the philosophy of mind into the language of Mindless Sensationalism, one may be able to come up with some precise formulations for them that would be applicable to the real universe and not just to some imaginary universe that is modeled by, say, some classical Turing machine.

Similarly, it would also be an interesting challenge to interpret other approaches to the problems of consciousness within the framework of Mindless Sensationalism. If they cannot be interpreted within this framework, one would need to invent another framework in which they might be interpreted in order for them to be consistent with our quantum universe. This might impose a nontrivial constraint on approaches to the problems of consciousness.

In conclusion, I am proposing that Mindless Sensationalism is the best framework we have at the present level for understanding the connection between conscious experiences and quantum theory. Of course, the framework would only become a complete theory once one had the set  $M$  of all conscious experiences  $p$ , the awareness operators  $A(S)$ , and the quantum state  $\sigma$  of the universe.

Even such a complete theory of the quantum world and the conscious world affected by it need not be the ultimate simplest complete theory of the combined physical world. There might be a simpler set of unifying principles from which one could in principle deduce the conscious experiences, awareness operators, and quantum state, or perhaps some simpler entities that replaced them. For example, although in the present framework of Mindless Sensationalism, the quantum world (i.e., its state), along with the awareness operators, determines the measure for experiences in the conscious world, there might be a reverse effect of the conscious world affecting the quantum world to give a simpler explanation than we have at present of the coherence of our conscious experiences and of the correlation between will and action (why my desire to do something I feel am capable of doing is correlated

with my conscious experience of actually doing it, i.e., why I “do as I please”). If the quantum state is partially determined by an action functional, can desires in the conscious world affect that functional (say in a coordinate-invariant way that therefore does not violate energy-momentum conservation)? Such considerations may call for a more unified framework than Mindless Sensationalism (elsewhere called Sensible Quantum Mechanics), which one might call Sensational Quantum Mechanics [5, 6]. Such a more unified framework need not violate the limited assumptions of Mindless Sensationalism, though it might do that as well and perhaps reduce to Mindless Sensationalism only in a certain approximate sense.

To explain these frameworks in terms of an analogy, consider a classical model of spinless massive point charged particles and an electromagnetic field in Minkowski spacetime. Let the charged particles be analogous to the quantum world (or the quantum state part of it), and the electromagnetic field be analogous to the conscious world (the set of conscious experiences with its measure  $\mu(S)$ ). At the level of a simplistic materialist mind-body philosophy, one might merely say that the electromagnetic field is part of, or perhaps a property of, the material particles. At the level of Mindless Sensationalism, the charged particle worldlines are the analogue of the quantum state, the retarded electromagnetic field propagator (Coulomb’s law in the nonrelativistic approximation) is the analogue of the awareness operators, and the electromagnetic field determined by the worldlines of the charged particles and by the retarded propagator is the analogue of the conscious world. (Here one can see that this analogue of Mindless Sensationalism is valid only if there is no free incoming electromagnetic radiation.) At the level of Sensational Quantum Mechanics, at which the conscious world may affect the quantum world, the charged particle worldlines are partially determined by the electromagnetic field through the electromagnetic forces that it causes. (This more unified framework better explains the previous level but does not violate its description, which simply had the particle worldlines given.) At a yet higher level, there is the possibility of incoming free electromagnetic waves, which would violate the previous frameworks that assumed the electromagnetic field was uniquely determined by the charged particle worldlines. (An analogous suggestion for intrinsic degrees of freedom for consciousness has been made by the physicist Andrei Linde [46].) Finally, at a still higher level, there might be an even more unifying framework in which both charged particles and the electromagnetic field are seen as modes of a single entity (e.g., to take a popular current speculation, a superstring, or perhaps some more basic entity in “M theory”).

Therefore, although it is doubtful that Mindless Sensationalism is the correct framework for the final unifying theory (if one does indeed exist), it seems to me to be a move in that direction that is consistent with what we presently know about the physical world and consciousness.

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Council of Canada. Many of the people whom I have remembered as being influential in my formulation of my ideas are listed at the end of [5], though of course none of them are ultimately responsible for it, and indeed most of them might well disagree with it.

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